

# **Supporting NASA's Continuous Cost Risk Management (CCRM) Process with Active Risk Manager (ARM)**

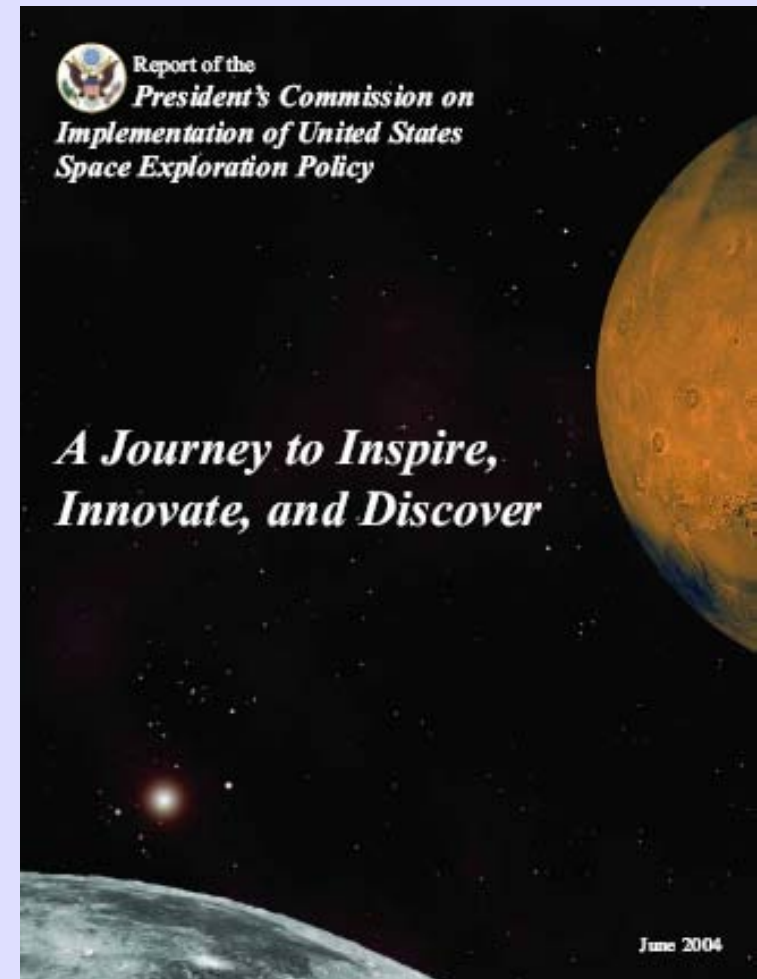
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**310.406.5684**

# Outline

- Continuous Cost Risk Management
- How Does ARM Support CCRM
- The Future

# 2004 Aldridge Commission Recommendations On NASA Cost Estimating

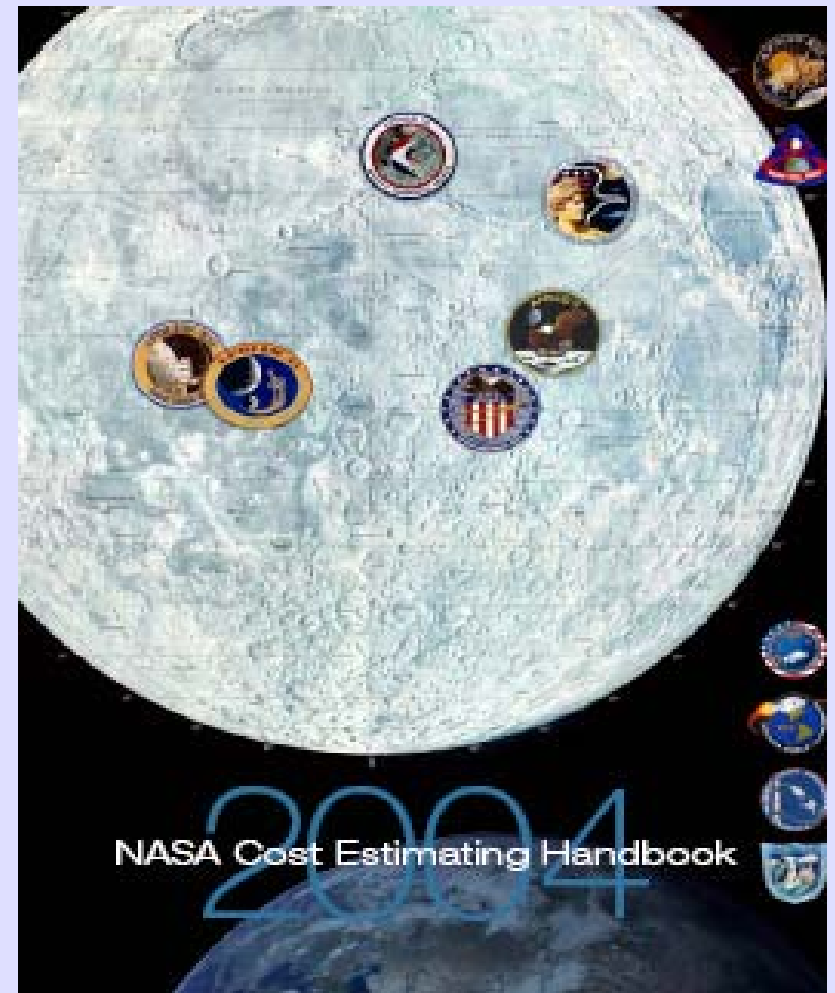
- Recommended an independent cost analysis organization similar to DoD CAIGs (Cost Analysis Improvement Group)
  - ◆ An independent cost estimating organization
  - ◆ Maintains corporate data base of historical project cost information
  - ◆ Generally uses parametric cost estimating procedures
  - ◆ Recommends final cost position to approving bodies



# NASA Cost Estimating Handbook

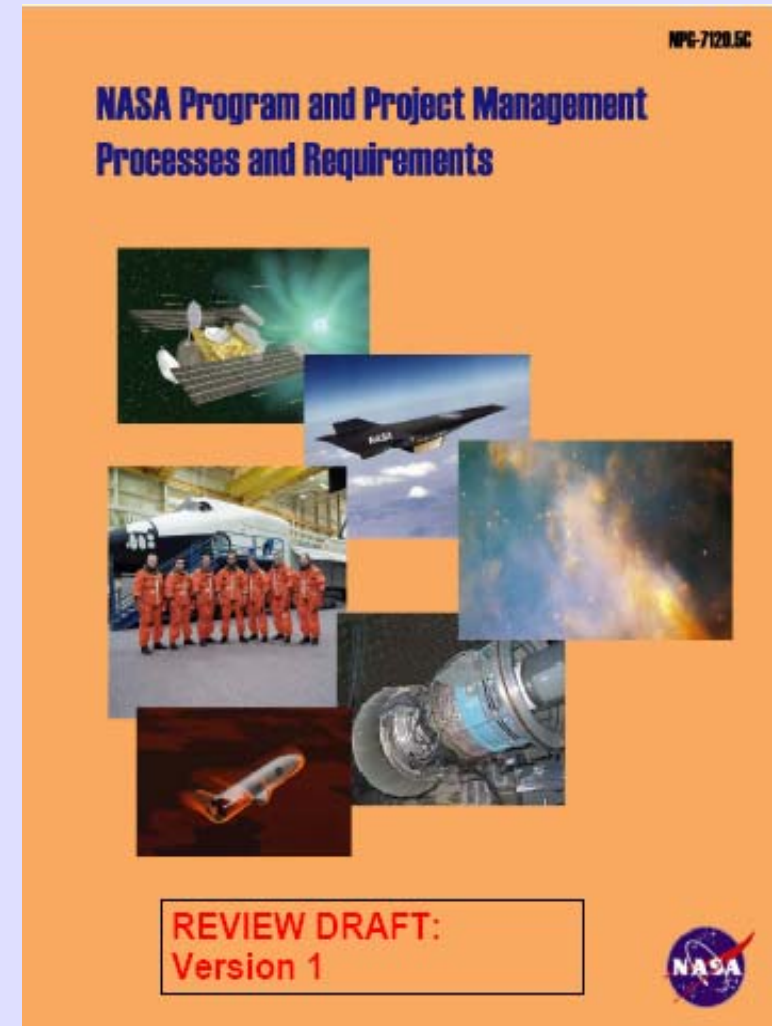


- Documents improved initiatives for Agency cost estimating ([www.keh.nasa.gov](http://www.keh.nasa.gov))
- Tied closely to NPR 7120.5C
- Initiatives include:
  - ◆ Use of Continuous Cost Risk Management (CCRM) to improve coordination across cost communities of practice
  - ◆ Use of cost risk analysis to quantify uncertainty
  - ◆ Improved cost data collection using a Cost Analysis Data Requirement (CADRe)



# NASA Program & Project Management Processes & Requirements: NPR 7120.5C

- Covers all aspects of program and project management at NASA, including....“Cost, Risk and Performance Management Integration”
- Context is the Cost-Risk Feedback Continuum<sup>3</sup>
  - ◆ Discipline architecture designed for maximizing the quality of cost management information that:
    - Is a “system of cost systems”
    - Removes the “stove piped” nature of cost disciplines
    - Links cost disciplines together by **common risk management threads**
  - ◆ Manifests the interconnectedness of cost and schedule disciplines in *setting up, getting, and using* cost and schedule risk feedback for successful project and risk management



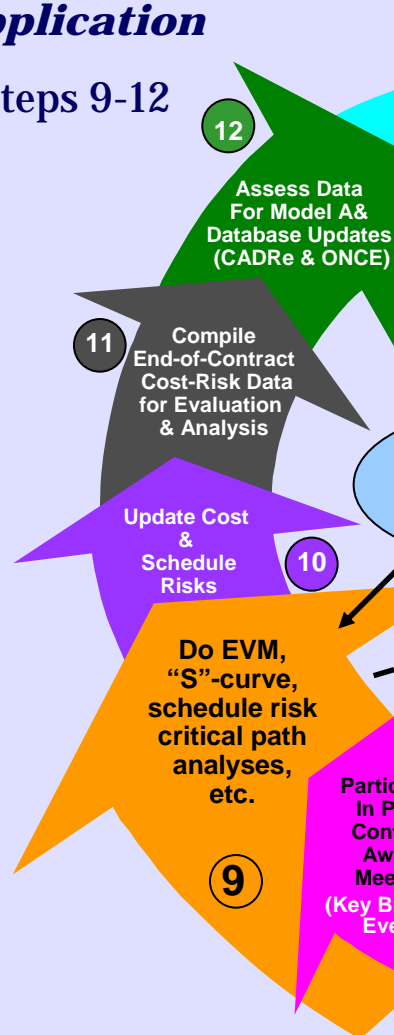
# Continuous Cost-Risk Management

- Three-Staged Cost management architecture providing:

- ◆ Early ID & cost impacts of medium & high risk WBS elements in cost estimate
- ◆ Communication of WBS element risk to project managers for ***focused*** cost management
- ◆ Post - cost estimate tracking of identified WBS element risk ***using EVM system***
- ◆ Update, collection and archiving of technical, cost and cost-risk data for cost model improvement

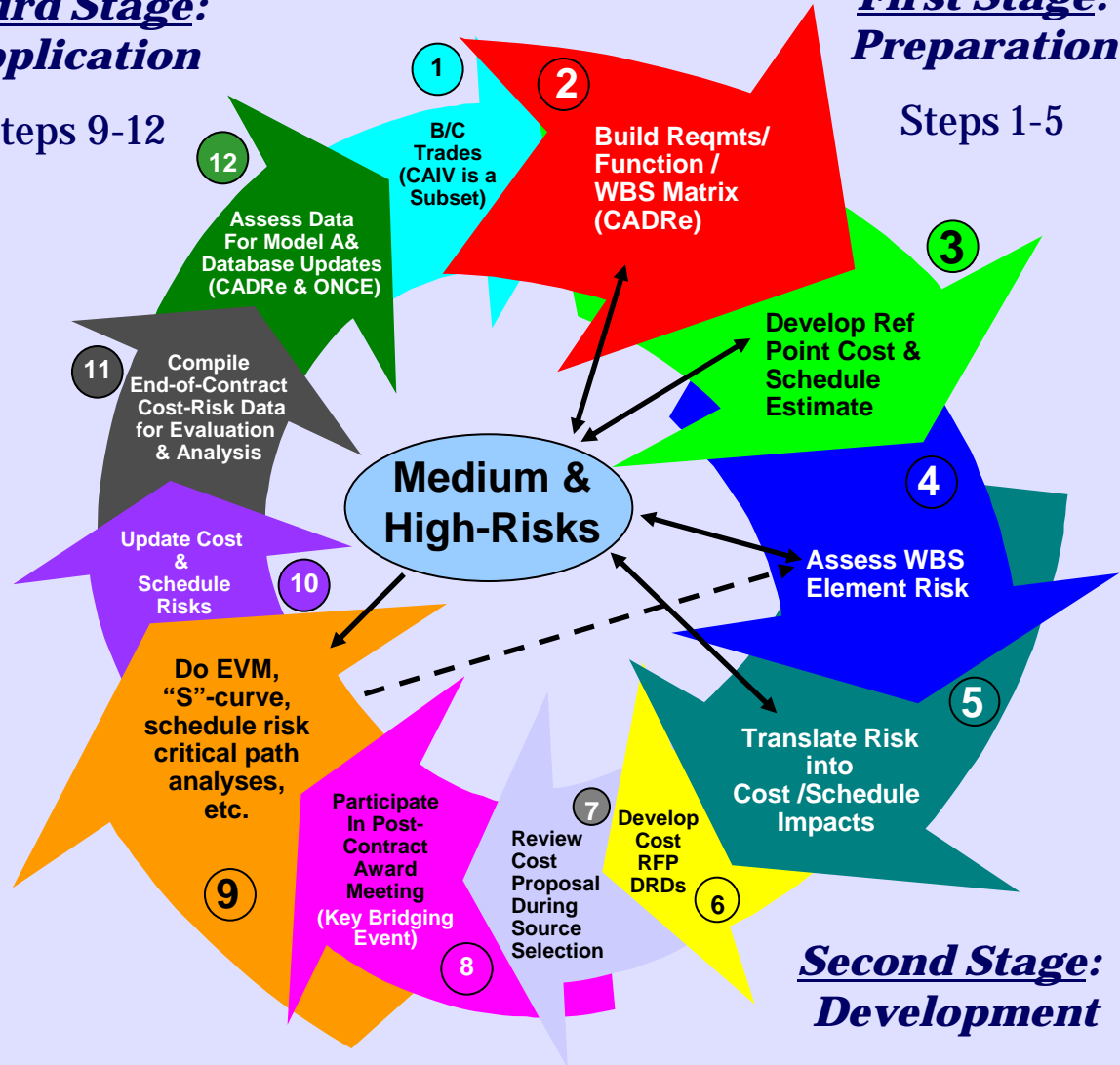
## Third Stage: Application

Steps 9-12



## First Stage: Preparation

Steps 1-5



## Second Stage: Development

Steps 6-8

***Incorporated in NPR 7120.5C***

# Three Main Stages CCRM

- *Preparing* for cost-risk feedback
- *Developing* cost-risk feedback
- *Applying* cost-risk feedback

## Cost management

**IS** the management of cost - risk ...  
characterized by continuous feedback on  
cost-risk

# First CCRM Stage

- ***Preparing*** for cost risk feedback: Project teams perform three main activities:
  - ◆ Cost/performance trades (e.g., Cost as an Independent Variable (CAIV))
  - ◆ Develop a definition of the program (e.g., part of the Cost Analysis Data Requirements (CADRe))
  - ◆ Produce a range of possible costs
- Cost/performance trades are the first opportunity to identify potential cost impacts due to risk
- Participants are cost estimators, project engineers and project managers
- Starting point for cost-risk management
- Challenge in managing to the cost level chosen, no matter what cost-risk margin has been included



## Second CCRM Stage

- ***Developing*** the feedback to manage cost-risks
  - ◆ Contractors must be informed about the potential cost-risk impacts identified by the NASA cost teams for their attention, monitoring, management, and reporting
  - ◆ Contractors must be informed in the Request for Proposal (RFP) Data Requests (DR) to produce multiple products that reflect the status and trends of these potential cost-risks
    - required to produce a Life Cycle Cost Estimate (LCCE)
    - identify the “S”-curve products of these requirements for of variance changes in cost-risk distribution over time
    - required to monitor, manage, and report monthly on the top medium and high-risk WBS elements
    - require monthly Estimates at Completion (EAC) reports on all medium and high-risk WBS elements
    - required electronic access to this data

## Third CCRM Stage

- ***Applying*** cost-risk feedback for managing costs
- Focus on medium and high-risk WBS elements
- Action on:
  - ◆ If cost and schedule performance analysis indicates problems
  - ◆ EVM performance analysis, focused on risk impacts to cost and schedule, will enable development of monthly EACs providing the project manager crucial feedback on the potential cost effects of the risks
  - ◆ This information provides the project manager with focused insight into the cost-risk in order to better manage his/her costs
  - ◆ The end of the effort a volume of high-quality cost, risk, and cost-risk information is collected for follow-on contractor performance analysis, cost-risk methodology calibration and updating cost models in order to better cost estimate future projects

# **How Does ARM Play A Part?**

# What is Active Risk Manager (ARM)



- ARM is a Web-Based Enterprise-Wide Risk Management system
- Provides the right information to the right people at the right time
- Identify, assess, manage, and communicate risks
- ARM is a **Living System** that processes information in the form of feedback to initiate and sustain progress



# ARM – Main Risk Review Area



ID	Risk Title	Owner	Status	Risk Level
4	Market May Be Less Than Expected	STL	Active	Hi Threat
11	Excessive Work Load	STL	Active	Hi Threat
1	Integration Delayed Due To Interface Problem	STL	Active	Hi Threat
3	Delays In Obtaining Planning Permission	STL	Active	Hi Threat
5	Experience Of Project Team	STL	Active	Hi Threat
6	Failure Of JV	STL	Active	Hi Threat
7	System Design Too Complex For Existing IT (Waterfall)	STL	Active	Hi Threat
9	Excessive Work Load	STL	Active	Hi Threat
10	Lack Of Resources	STL	Active	Hi Threat
1	Integration Delayed Due To Interface Problem	STL	Active	Med Threat
7	System Design Too Complex For Existing IT (Waterfall)	STL	Active	Med Threat
7	System Design Too Complex For Existing IT (Waterfall)	STL	Active	Low Threat
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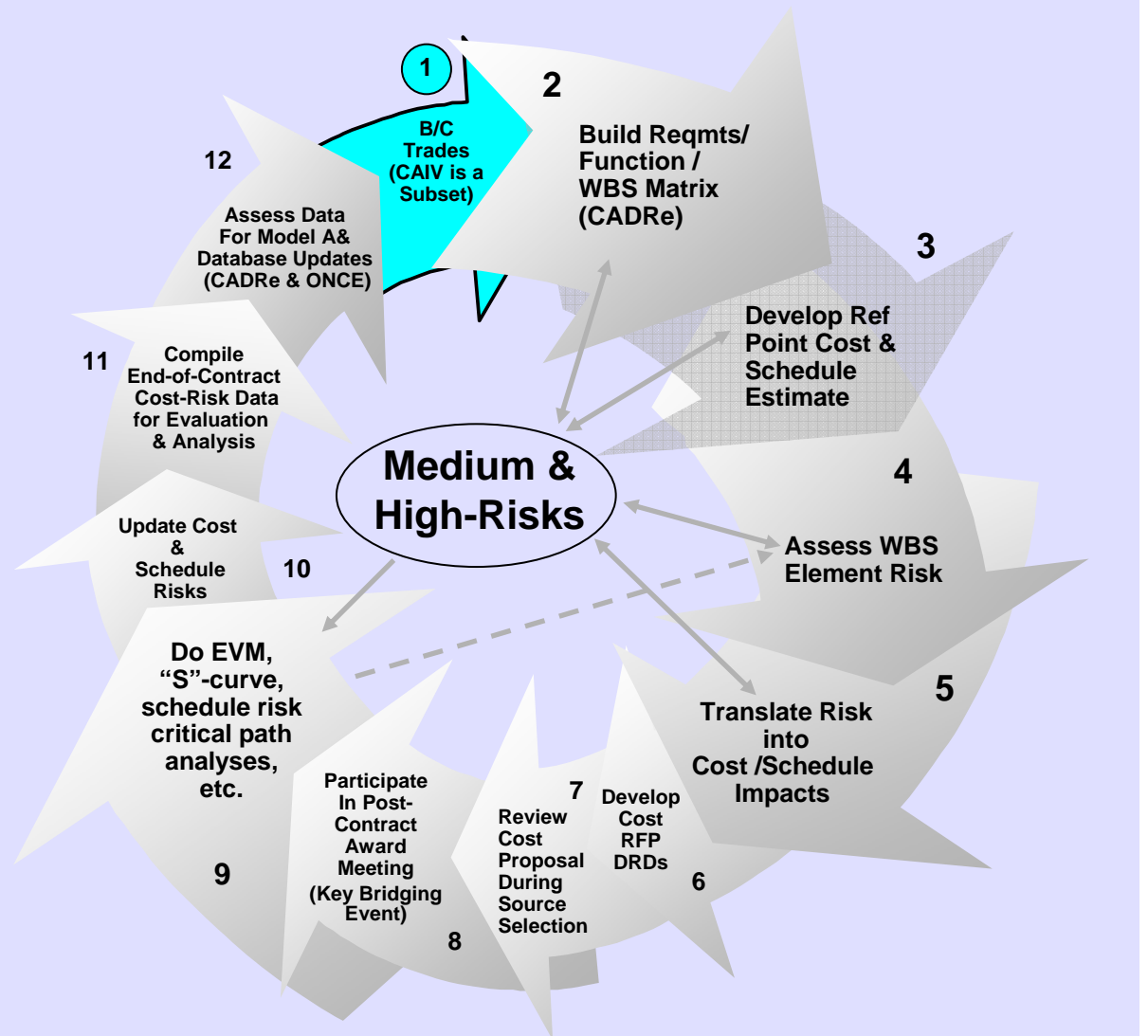
  

Mitigation Step ID	Title	Target	V1 Due Date	Owner	Status
3	Issue IT Document	0.50	10 Feb 2002	STL	Complete
4	Review Requirements	0.50	10 May 2002	STL	Complete
5	Issue Work Plans	0.40	10 Aug 2002	R Oden	Complete
6	Monitor Design Development	0.30	21 Sep 2002	STL	Complete
7	Design Review	0.20	12 Oct 2002	STL	Complete

- Supports projects, programs and enterprise level risk management
- Scalable from 2-3 to thousands of users (16,000 Boeing)
- It's integrated with leading tools

# CCRM Stage 1: Preparation

- Establish the baseline and mechanisms required to manage and control project costs and risks



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- Establish the baseline and mechanisms required to manage and control project costs and risks

ACTIVE RISK MANAGER - Default - with PBF PIC:Example Organisation - Microsoft Internet Explorer

## ACTIVE RISK MANAGER RISK REVIEW

File Edit New Review View Link Analysis Reports Tools Help -- Filters ON --

Requirements Business Activities

Example Organisation

- Projects
  - Future Satellite
    - Launch vehicle
      - Power Pack
        - Nuclear Shield
    - Processors
  - Performance
  - Security
    - Employee Safety
    - Premises
    - Equipment
  - Health and Safety
    - Health and Safety at Work Act
    - Fire Safety
    - Site Safety
  - Controls Assurance
    - Corporate Governance
  - Environmental
    - Legislation
      - Pollution
      - Emissions
      - Disposal
      - Noise

Example Organisation

- Energy Services
- Graphics Corp
  - Projects
    - Future Satellite
      - Flight Test Centre
        - Ground Equipment
          - Develop Program Plan
          - Develop System Arch
          - Preliminary Design
          - Baseline Des/Build/Te
        - Missile
          - Develop Program Plan
          - Develop System Arch
          - Preliminary Design
          - Baseline Des/Build/Te
          - Integration of Ground
          - Engineering Flight Tes
        - test
          - test
          - test
          - test
          - test
      - Handover
    - FASTTRAX
    - Rail Project
    - Telecoms Group
    - Equipment Group
    - JV

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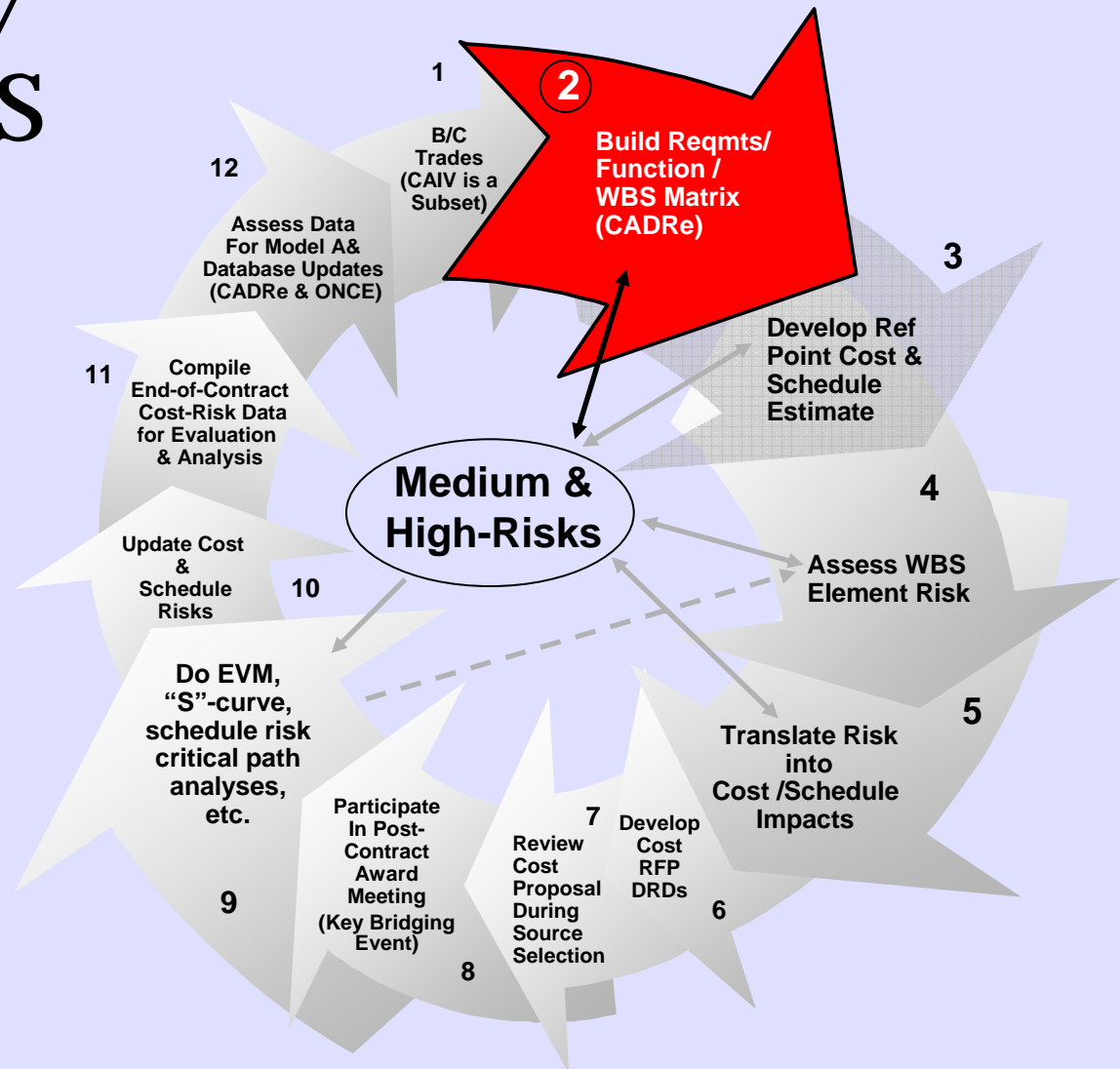
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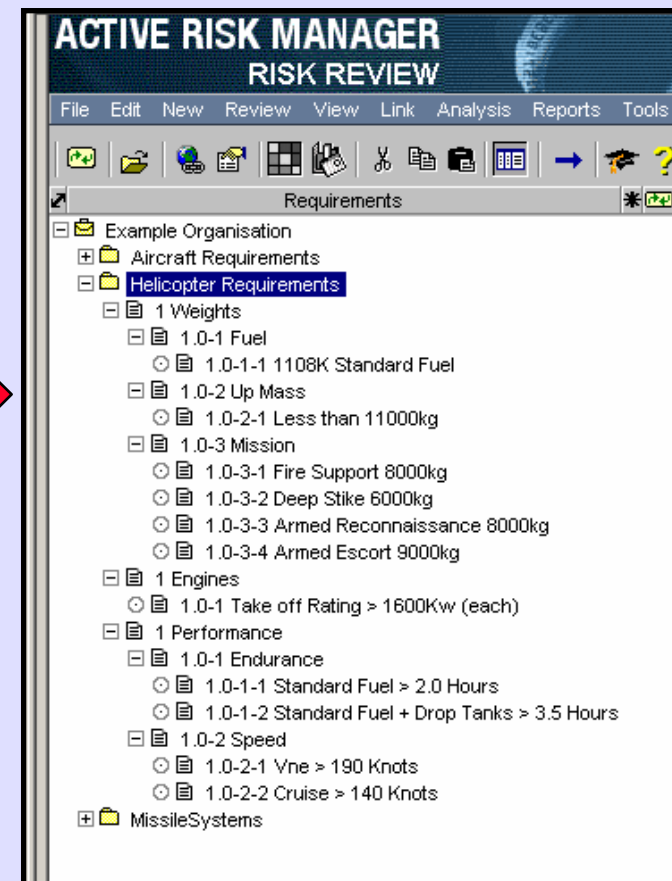
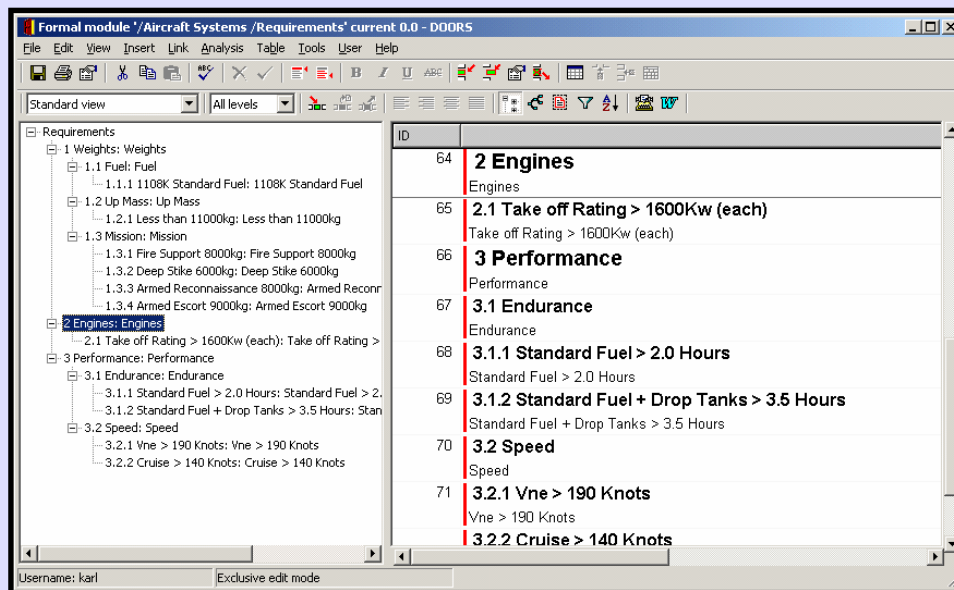
- Build requirements / function / WBS Matrix





# CCRM Stage 1: Preparation

## • Linking Requirements to Risk Management



# CCRM Stage 1: Preparation

## • Import Requirements

**ACTIVE RISK MANAGER - Default - with P&P PIC:Example Organisation - Microsoft Internet Explorer**

**ACTIVE RISK MANAGER**  
**RISK REVIEW**

File Edit New Review View Link Analysis Reports Tools Help -- Filters ON --

**Requirements**

- Example Organisation
  - Projects
    - Future Satellite
      - Launch vehicle
        - Power Pack
          - Nuclear Shield
- Performance
- Security
  - Employee Safety
  - Premises
  - Equipment
- Health and Safety
  - Health and Safety at Work Act
  - Fire Safety
  - Site Safety
- Controls Assurance
  - Corporate Governance
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  - Legislation
    - Pollution
      - Emissions
    - Disposal
    - Noise

**Business Activities**

- Example Organisation
  - Energy Services
  - Graphics Corp
    - Projects
      - Future Satellite
        - Flight Test Centre
          - Flight Test Centre
            - Ground Equipment
              - Develop Program Plan
              - Develop System Arch
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**Risk Review Table**

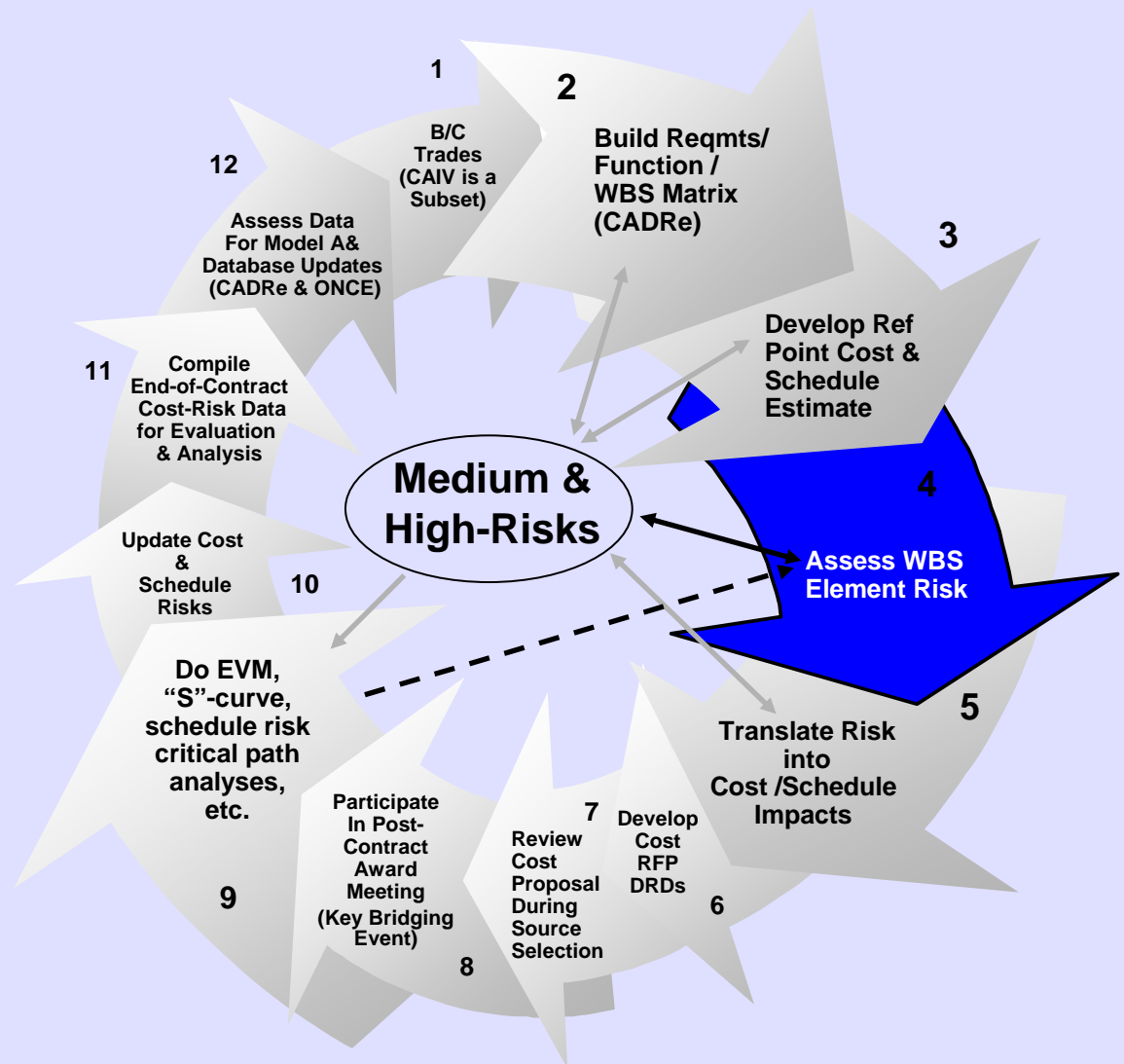
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**Related Mitigation Steps Of Risk ID: 7 - 'System Design Too Comp..'**

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# CCRM Stage 1: Preparation

- Assess WBS element risk



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ACTIVE RISK MANAGER - Default - with PDF PIC:Example Organisation - Microsoft Internet Explorer

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File Edit New Review View Link Analysis Reports Tools Help -- Filters ON --

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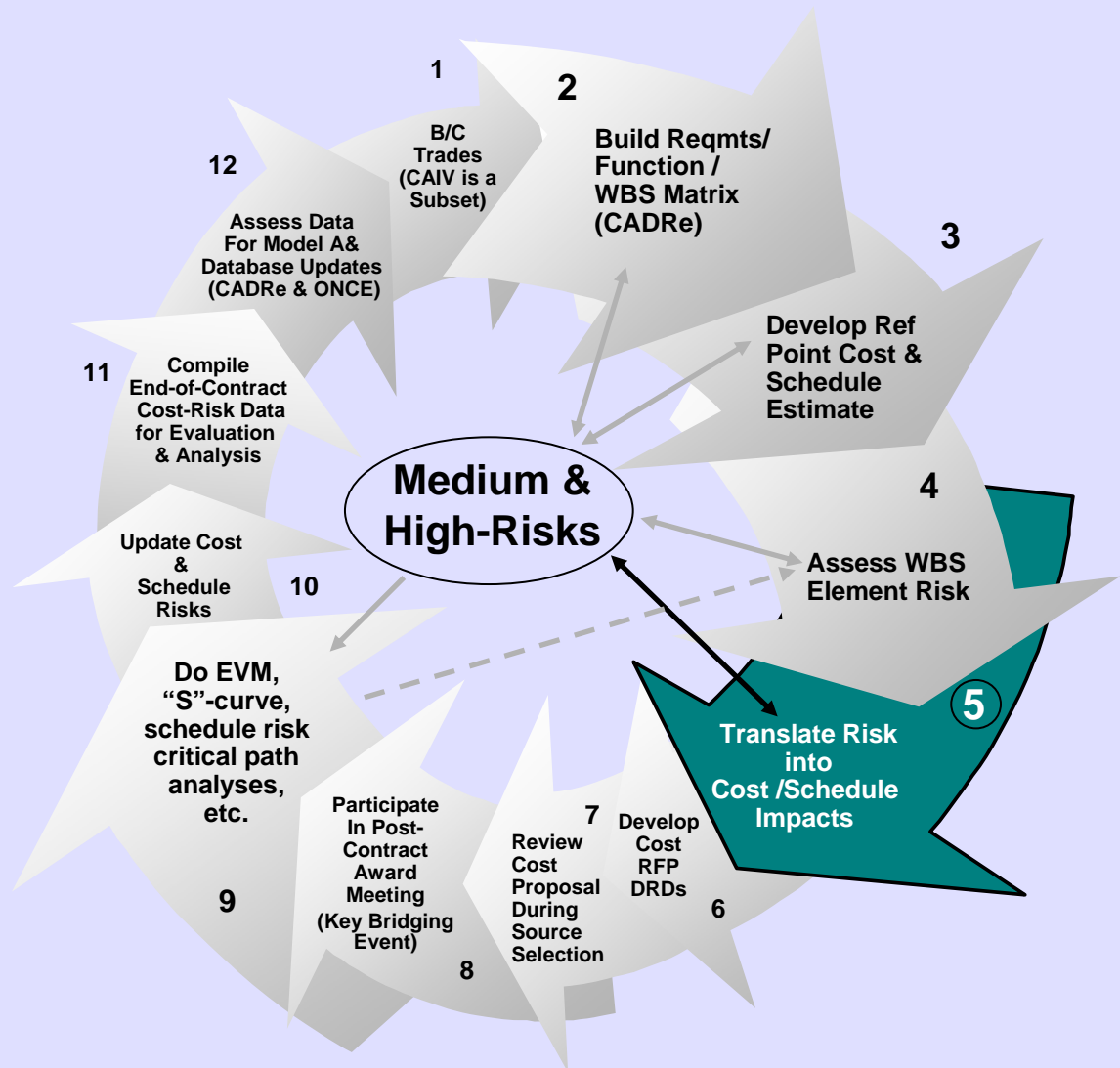
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**Medium /  
High Risks**

# CCRM Stage 1: Preparation

- Translate risk into cost / schedule impacts



# CCRM Stage 1: Preparation

Level	Given the Risk Is Realized, What Is the Magnitude of the Impact?		
	Performance	Schedule	Cost
a	Minimal or no impact	Minimal or no impact	Minimal or no impact
b	Acceptable with some reduction in margin	Additional resources required; able to meet need dates	<5%
c	Acceptable with significant reduction in margin	Minor slip in key milestones; not able to meet need date	5-7%
d	Acceptable; no remaining margin	Major slip in key milestone or critical path impacted	7-10%
e	Unacceptable	Can't achieve key team or major program milestone	>10%

Table 2-3. Consequences/Impacts Criteria (Example)

Level	What is the Likelihood the Risk Event Will Happen?
a	Remote
b	Unlikely
c	Likely
d	Highly Likely
e	Near Certainty

Table 2-2. Probability/Likelihood Criteria (Example)

- ARM Scoring Scheme is a named set of "rules" for carrying out risk scoring:
  - mapping specific probability and impact values
  - consists of a set of score band definitions for Probability, Cost, Time /additional impact categories

## Qualitative View

Scoring Schemes Configuration - Microsoft Internet Explorer

Scoring Schemes Configuration

Scoring Scheme: Coporate Scoring (2)

Default: [X] Available for Re-assessment

This default scoring scheme cannot be deleted. You can however modify the values in this scheme.

Qualitative View

Probability (%)	RR	Low	Minor	Major
0	RR	Low Probability between 0 and 20% chance of occurring	Minimum Probability between 20 and 40% chance of occurring	Minimum Probability between 40 and 60% chance of occurring
10	RR	Overrun to the budget of up to 50K	Minimum Overrun to the budget of up to 100K	Minimum Overrun to the budget of up to 150K
20	RR	Low programme slippage of up to 2-weeks delay	Minimum programme slippage of up to 4-weeks delay	Minimum programme slippage of up to 6-weeks delay
30	RR	Low programme slippage of up to 2-weeks delay	Minimum programme slippage of up to 4-weeks delay	Minimum programme slippage of up to 6-weeks delay
40	RR	Low programme slippage of up to 2-weeks delay	Minimum programme slippage of up to 4-weeks delay	Minimum programme slippage of up to 6-weeks delay
50	RR	Low programme slippage of up to 2-weeks delay	Minimum programme slippage of up to 4-weeks delay	Minimum programme slippage of up to 6-weeks delay
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80	RR	Low programme slippage of up to 2-weeks delay	Minimum programme slippage of up to 4-weeks delay	Minimum programme slippage of up to 6-weeks delay
90	RR	Low programme slippage of up to 2-weeks delay	Minimum programme slippage of up to 4-weeks delay	Minimum programme slippage of up to 6-weeks delay
100	RR	Low programme slippage of up to 2-weeks delay	Minimum programme slippage of up to 4-weeks delay	Minimum programme slippage of up to 6-weeks delay

OK Cancel Help

## Quantitative View

Scoring Schemes Configuration - Microsoft Internet Explorer provided by Northrop Grumman Corporation

Scoring Schemes Configuration

Scoring Scheme: 1M Project (2)

Default: [X] Available for Re-assessment

This default scoring scheme cannot be deleted. You can however modify the values in this scheme.

Quantitative View

Probability (%)	RR	1:Very Unlikely (A)	2:Unlikely (B)	3:Possible (C)	4:Substantial (D)	5:Very Likely (E)
0	RR	0	10	20	30	40
10	RR	0	10	20	30	40
20	RR	0	10	20	30	40
30	RR	0	10	20	30	40
40	RR	0	10	20	30	40
50	RR	0	10	20	30	40
60	RR	0	10	20	30	40
70	RR	0	10	20	30	40
80	RR	0	10	20	30	40
90	RR	0	10	20	30	40
100	RR	0	10	20	30	40

OK Cancel Help



# CCRM Stage 1: Preparation

- Translate risk into cost / schedule impacts
- Select the probability and the applicable impact category, i.e., cost, schedule, performance, etc.

Impact Assessment Scoring Criteria - Microsoft Internet Explorer

### Impact Assessment Scoring Criteria \*

Scoring Scheme:

Qualitative ☐ Quantitative ☒ Threat ☐ Opportunity ☒ Assessments Exposure Status: ☒ Current ☐ Target

	0:Nil	1:Very Low	2:Low	3:Moderate	4:High	5:Very High
<b>Probability</b>	0:Nil	1:Very Low	2:Low	3:Moderate	4:High	5:Very High
Probability (%)	Nil	Low Probability	Minimum Probability	Moderate Probability	Significant Probability	High Probability
<b>Threat</b>	0:Nil	1:Very Low	2:Low	3:Moderate	4:High	5:Very High
Cost (\$)	Nil	No impact on milestones	Overrun to the budget for the effected activities of 1% or greater	Overrun to the budget for the effected activities of 5% or greater	Overrun to the budget for the effected activities of greater than 5%	Overrun to the budget exceeds Mgt Reserve
Time (Days)	Nil	No impact on milestones	No impact on critical path milestone. Up to 2-week delay to non-critical path	Up to one month impact on critical path milestone. Up to 1 month delay to non-critical path milestone	1 to 3 month impact on critical path	Greater than 3 months impact on the critical path
Performance (%)	Nil	Weight - negligible change. Performance - Negligible performance. Component Cost - negligible impact. Maintenance - Insignificant impact on maintenance metrics <10%. Reliability - Insignificant impact. Generic Design	Minimum Performance	Moderate Performance	Significant Performance	High Performance
Reputation (M/A)	Nil					

Assessments

Assess Delete Impact Threat Band Value

Scheme	Overall Score	Risk Level
Template	0.7	High

OK Apply Cancel Help

# CCRM Stage 1: Preparation

- Current cost / schedule impact assessment

**ACTIVE RISK MANAGER**  
DETAIL VIEW

File Edit New View Link Analysis Reports Tools Help

Identify Analyze Plan Track & Control Save X

**General Details**

Risk ID: 8 Risk Title: Incomplete requirements definitions Black Flag Impact: None  
Impact ID: 8 Activity: ESMD Impact Group: Undefined  
Scoring Scheme: ESMD

☒ Description / Rational

**Exposure**

**Current Exposure** ☒ Threat ☐ Opportunity  
Probability: 41.5 % Status: 4:High

**Target Exposure** ☒ Threat ☐ Opportunity  
Probability: 0 % Status: 0:Nil

**Impacts**

	Min	Most Likely	Max	Status
Cost (\$)	1100000	1100000	1100000	2:Low
Time (Days)	46.88	46.88	46.88	3:Moderate
Performance (%)	30	30	30	2:Low
Safety (N/A)	10	10	10	1:Very Low
Unused				0:Nil

Current ROI: 0 Risk Level: 15 Moderate

**Dates** Initiation Date: 17 Feb 2005 Trigger: -- Expiry: -- Target Resolution: --



# CCRM Stage 1: Preparation

- Translate risk into cost / schedule impacts
- Helps the Cost Estimator's Cost-Risk Quantification Approach

The screenshot displays the 'ACTIVE RISK MANAGER' software interface. The main window is titled 'RISK REVIEW' and contains a table of risks. The table has columns for ID, Risk Title, Risk Owner, Status, Risk Level, and icons. The risks are listed as follows:

ID	Risk Title	Risk Owner	Status	Risk Level
13	Lack build capacity in dockyards	Emily Jones	Open	High
19	Engine performance may exceed requirement	Undefined	Open	High
21	Customer expectations on delivery timescales are not adequately understood	Jacob Smith	Open	High
25	Site Surveys	Jacob Smith	Open	High
43	(Summary Risk)	Michael Williams	Open	High
44	Target score high with high plan cost	Jenna Youssef	Open	High
46	Event	Jenna Youssef	Open	High
56	Antenna Structural Stiffness	Jacob Smith	Open	High
57	Antenna Motion Control Systems	Jacob Smith	Open	High
3	System Integration more complex than expected	Jacob Smith	Open	High
1	Unforeseen Ground Conditions - (Waterfall Risk)	Jacob Smith	Open	Medium
3	System Integration more complex than expected	Jacob Smith	Open	Medium
11	Unclear client requirements	Jacob Smith	Open	Medium

Below the main table, there is a section titled 'Related Impacts Of Risk ID: 3 - System Integration Mor.' which shows a tree view of impacts. The impacts are listed as follows:

ID	Tree Node	Tree	Trigger	Scheme	Risk Level
3	Combat Systems	Activity		Projects	High
17	Set To Work	Activity		Communications Systems Busines	Medium

The left sidebar of the interface shows a tree view of project requirements, including categories like 'Aircraft Requirements', 'Integration Requirements', 'Flight Systems', and 'Future Comb'. The 'Flight Systems (ID: 14)' is currently selected.

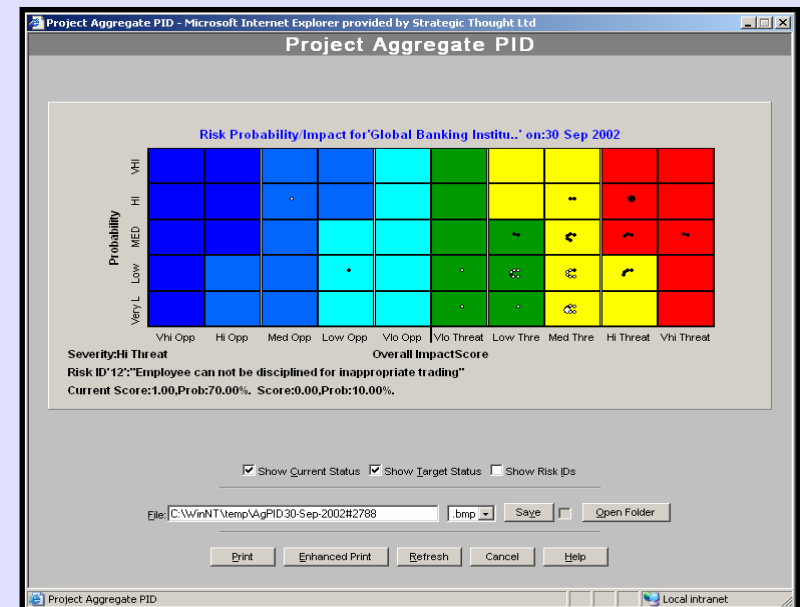
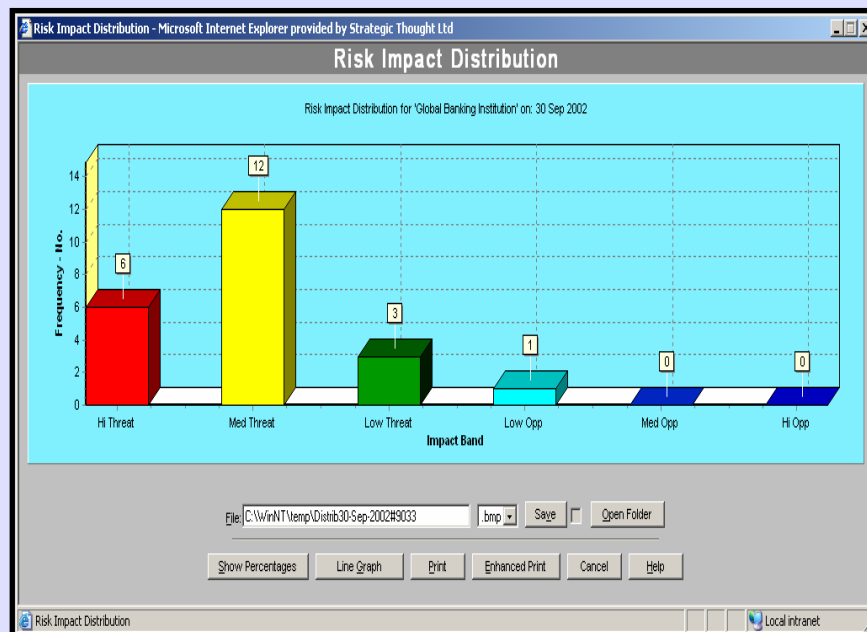
**Cost /  
Schedule  
Impacts**

# CCRM Stage 1: Preparation

- Translate risk into cost / schedule impacts

## RISK IMPACT DISTRIBUTION

How many risks do we have, what is their severity?

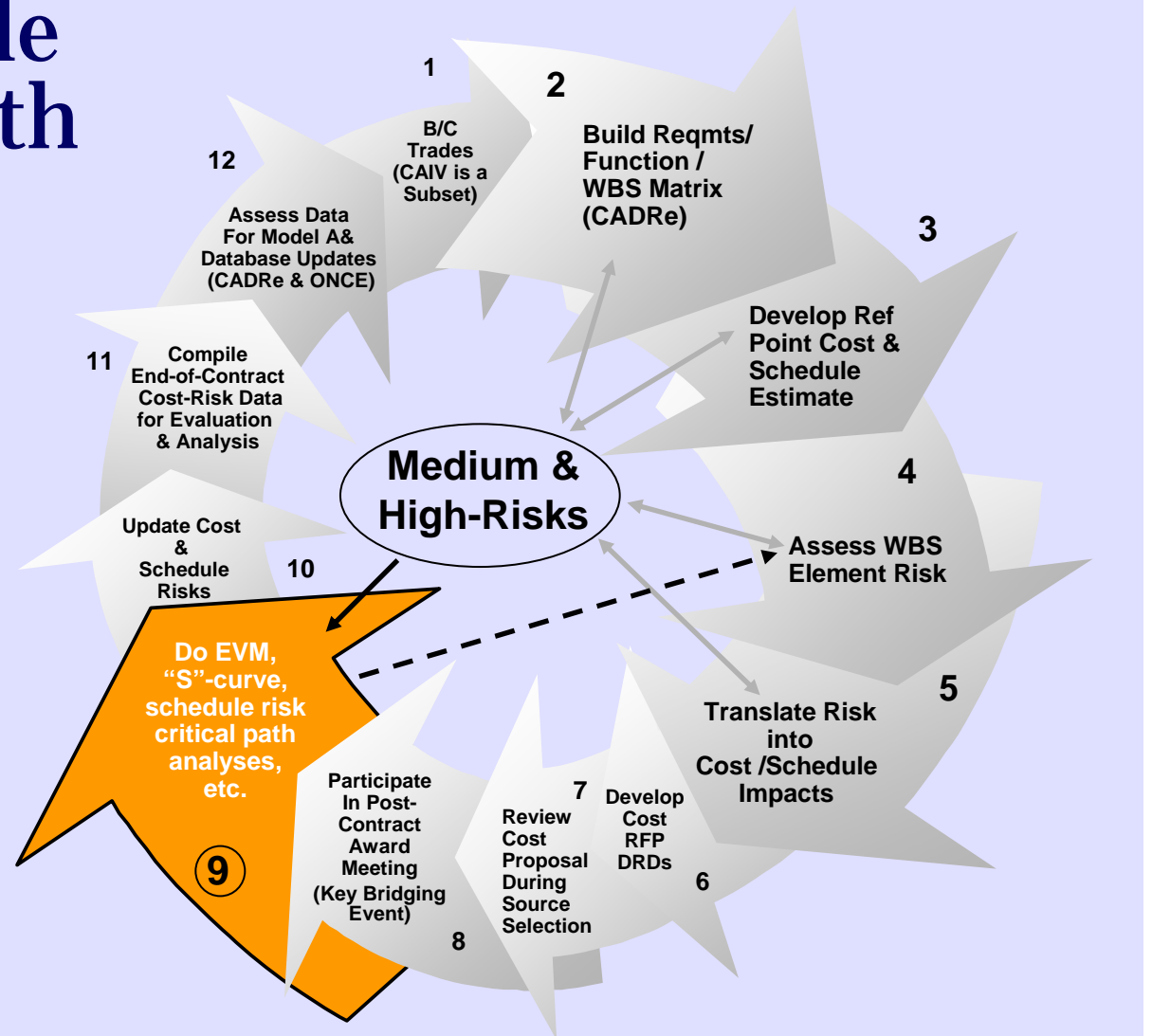


## PROBABILITY IMPACT DIAGRAMS

What is our aggregate view and how are we doing in our mitigation efforts?

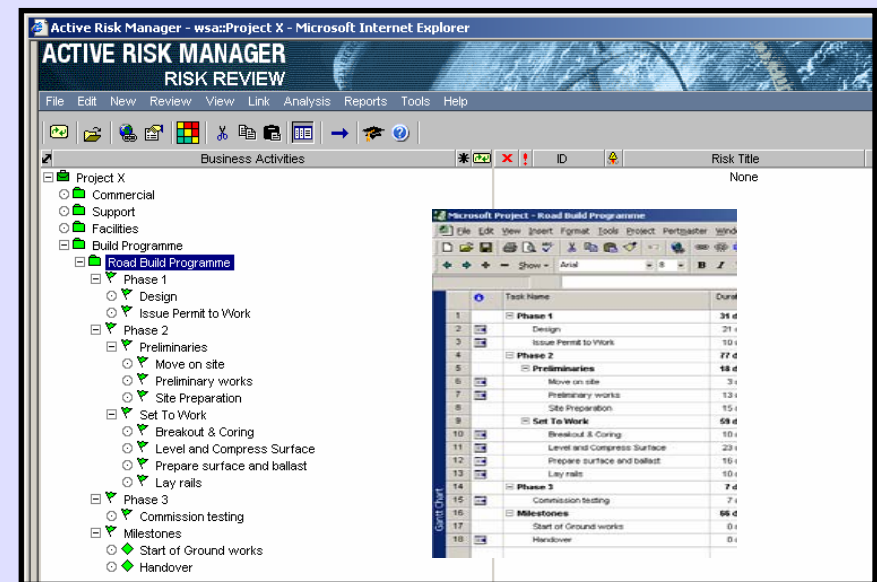
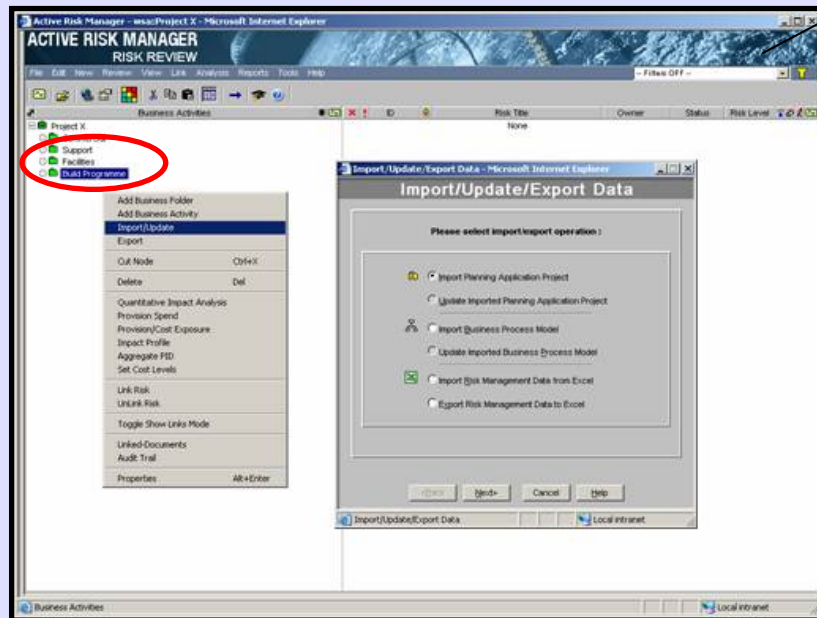
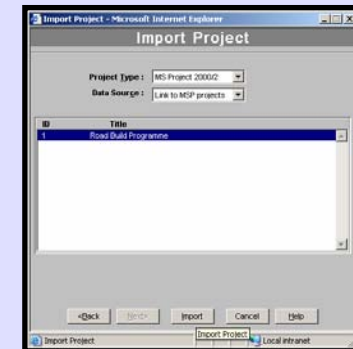
# CCRM Stage 3: Application

- Do EVM, 'S' – Curve, schedule risk critical path analyses
- Manage the project using cost-risk feedback data



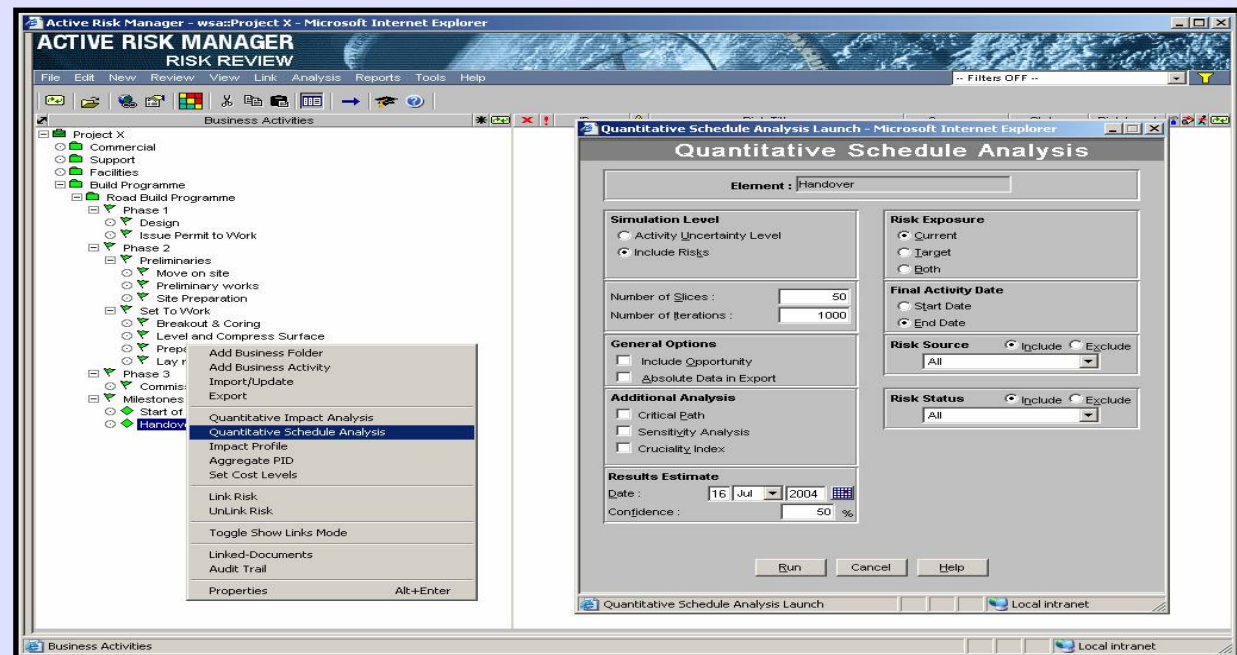
# CCRM Stage 3: Application

- Select the WBS for the plan to be imported in ARM
- Import schedule into ARM
- Use the import option



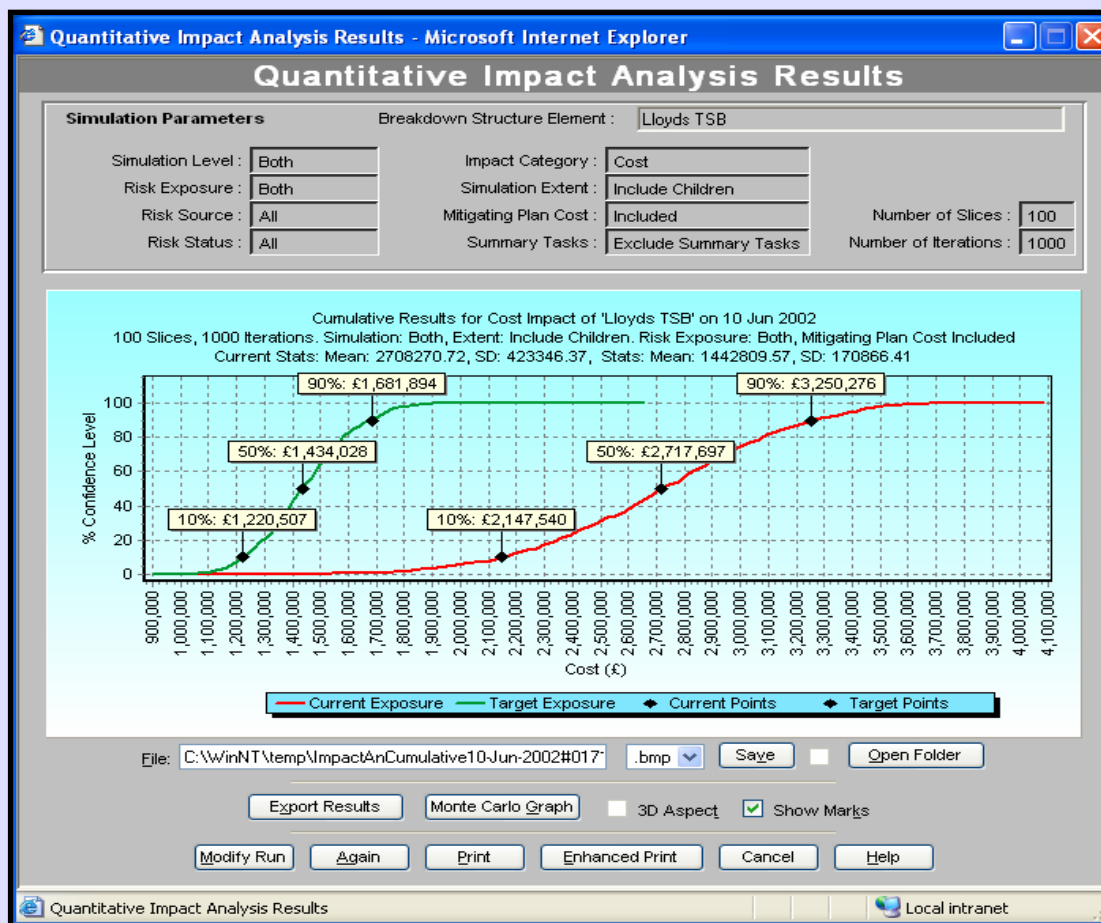
# CCRM Stage 3: Application

- Do 'S' – Curve, schedule risk critical path analyses
- Run an analysis on imported plan
- Select the target milestone / activity, select 'Quantitative Schedule Analysis' from the menu



# CCRM Stage 3: Application

- S-Curve (Monte Carlo) provides an assessment of final costs ...



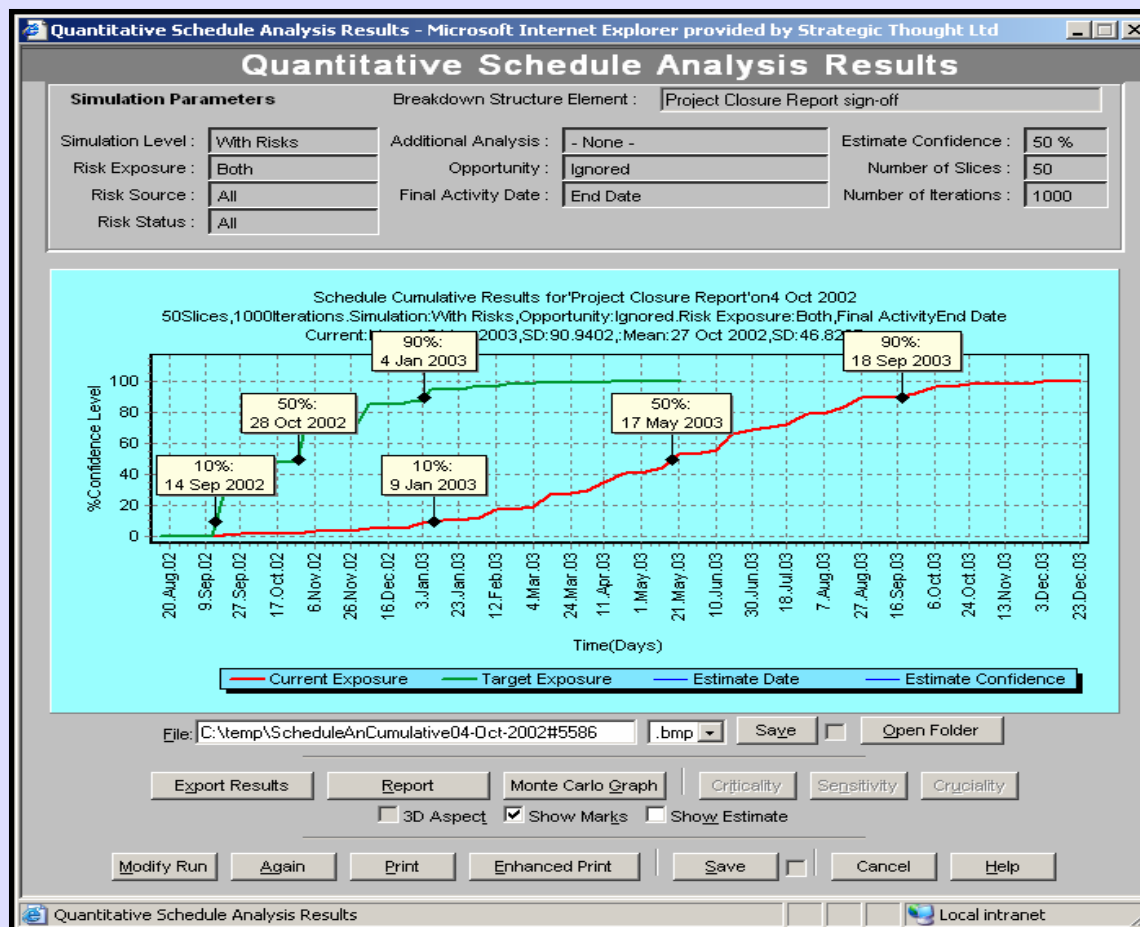
## QUANTITATIVE IMPACT ANALYSIS (S-Curve)

**What are the  
chances of  
completing the  
project to budget  
with current and  
target risk levels?**



# CCRM Stage 3: Application

- S-Curve (Monte Carlo) provides an assessment of completion timescales ...



## QUANTITATIVE SCHEDULE ANALYSIS (S-Curve)

**When are we  
likely to complete  
the project and  
how does this fit  
with the project  
plan?**

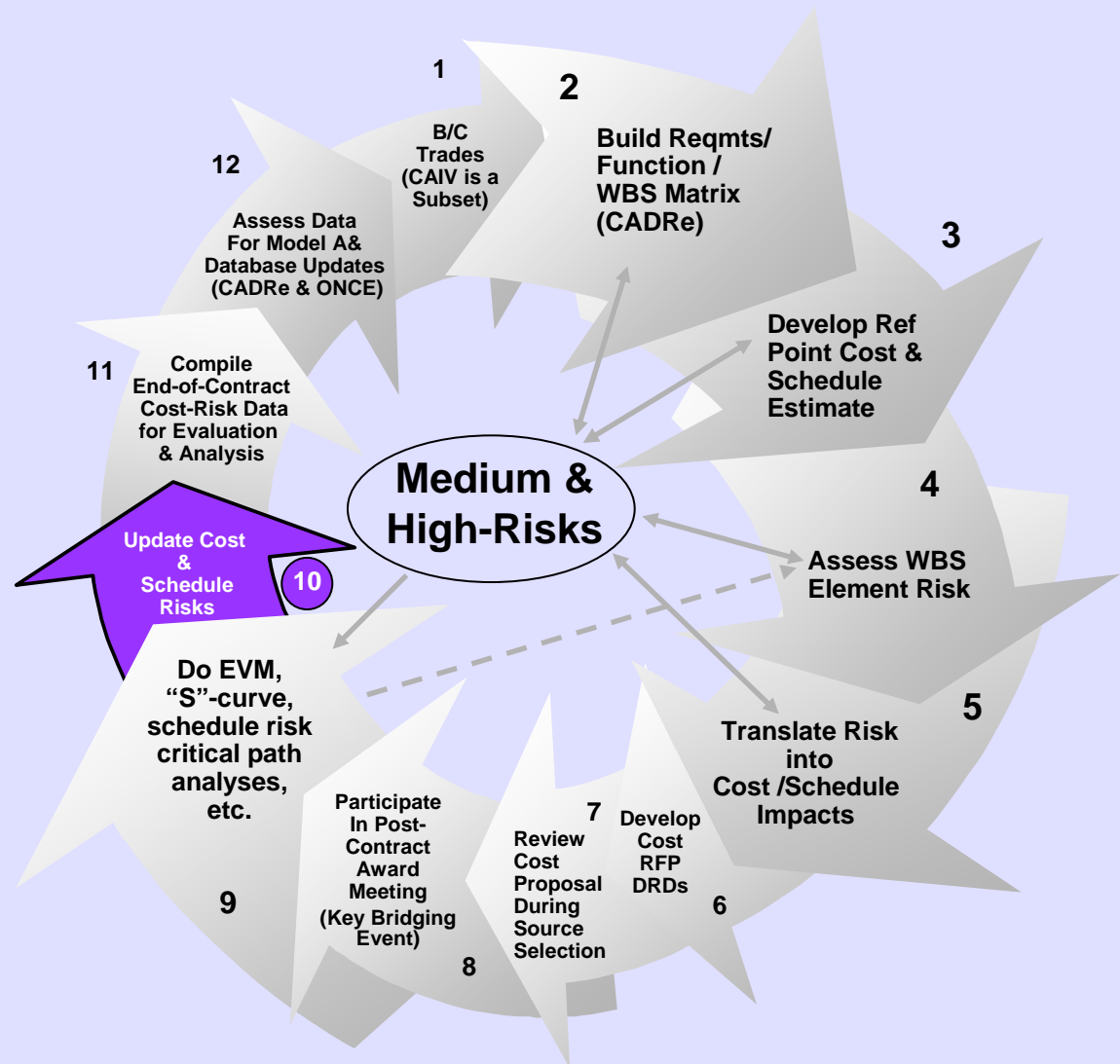
# CCRM Stage 3: Application

- Use the Analysis as a management tool
  - ◆ Realistic schedules
  - ◆ Understanding of effectiveness of mitigation actions
- Using contingency/provision reserves proactively
- Fund Management Actions
- Develop Opportunity realization
  - ◆ Calculate return on investment
  - ◆ Predict revenue requirements



# CCRM Stage 3: Application

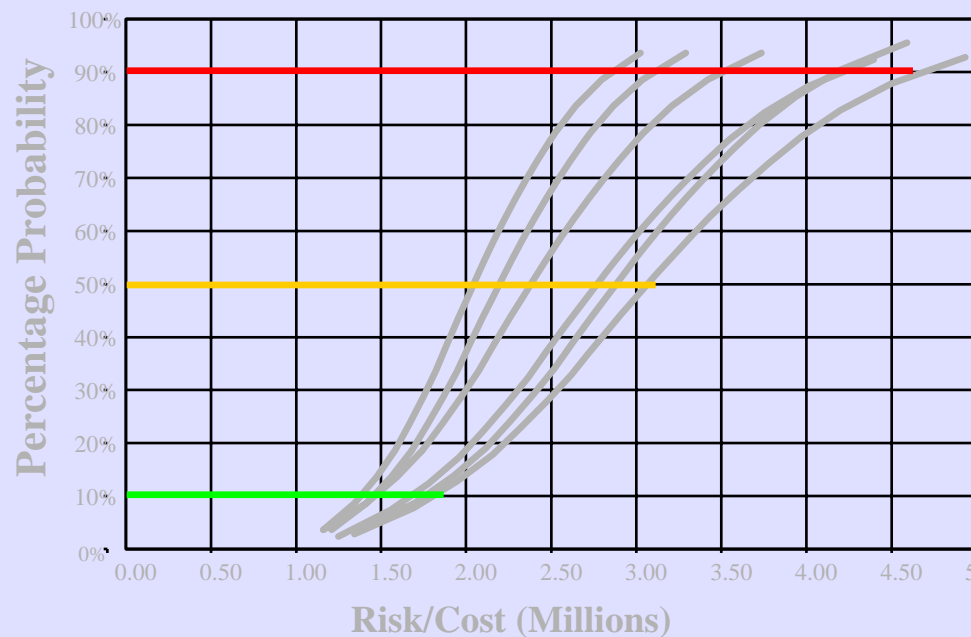
- Update cost and schedule risks



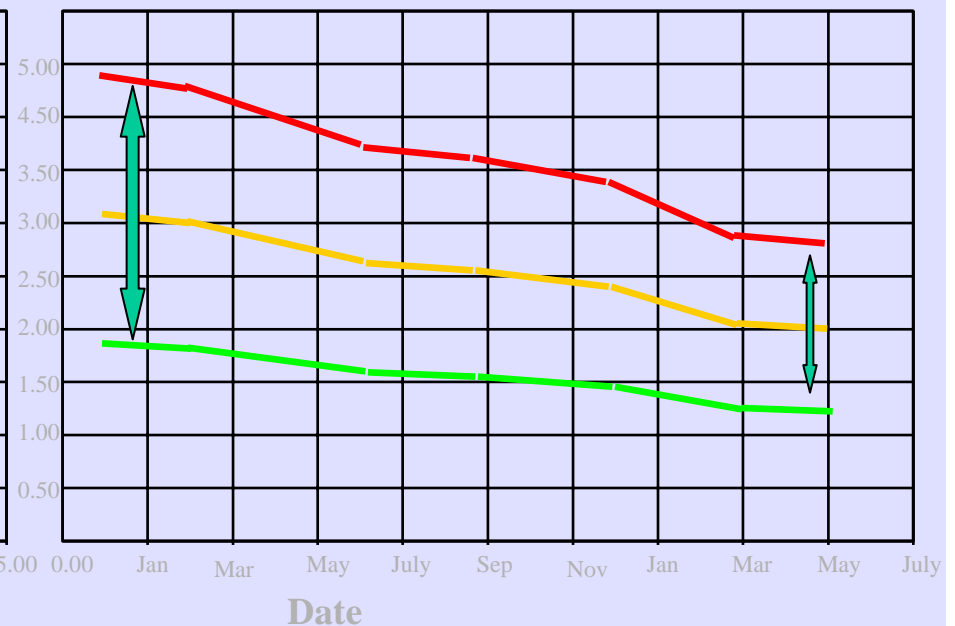
# CCRM Stage 3: Application

- Determine cost risk reduction

Results



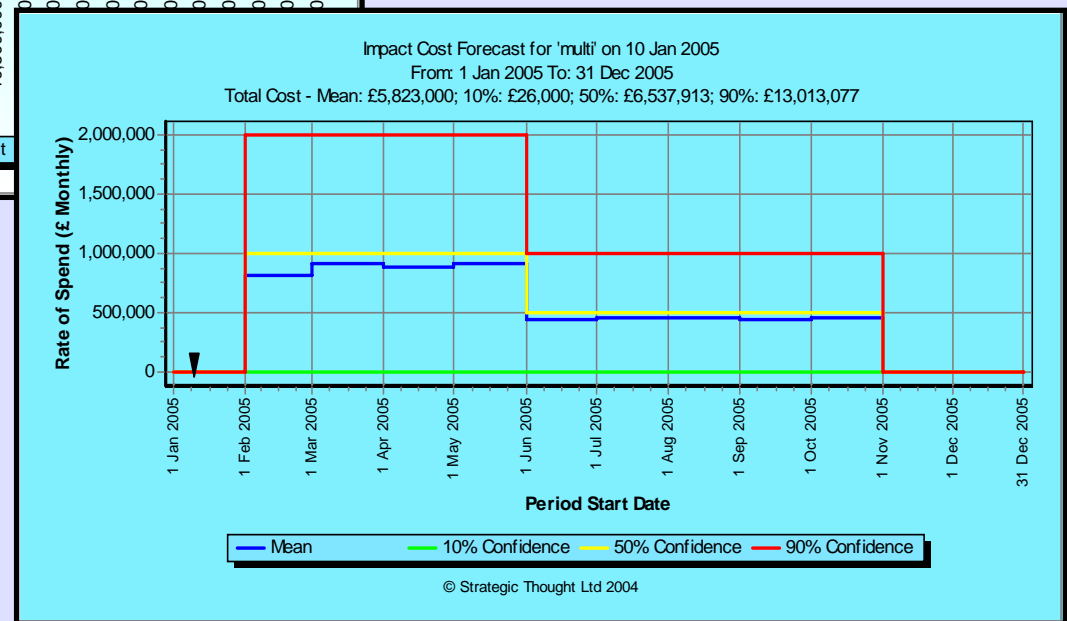
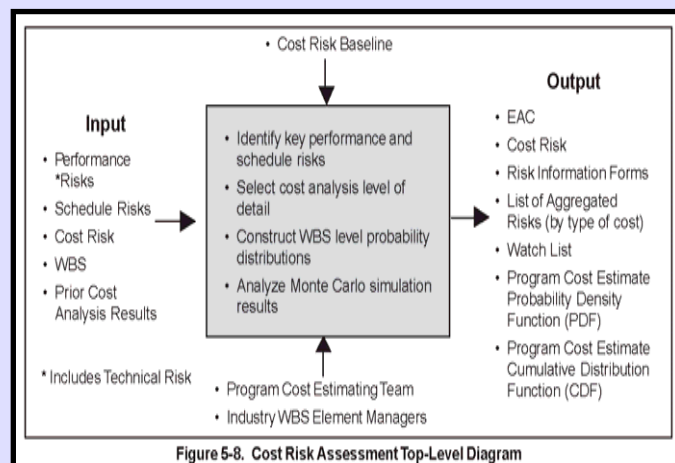
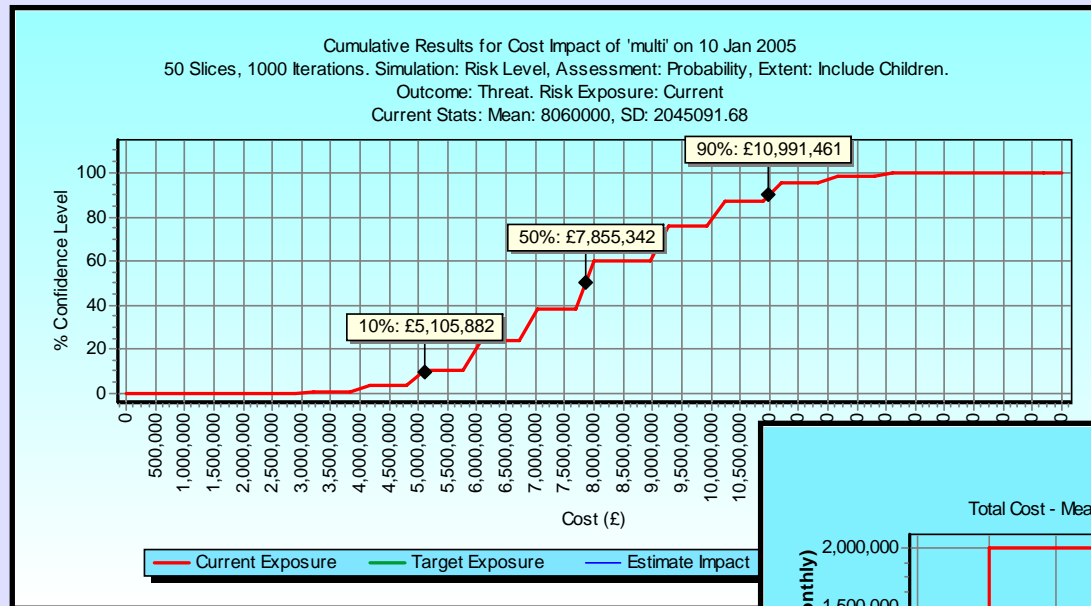
Reduction



- Need to understand the spread of risk
  - ◆ Retirement/Expiry dates
  - ◆ Mitigation Data

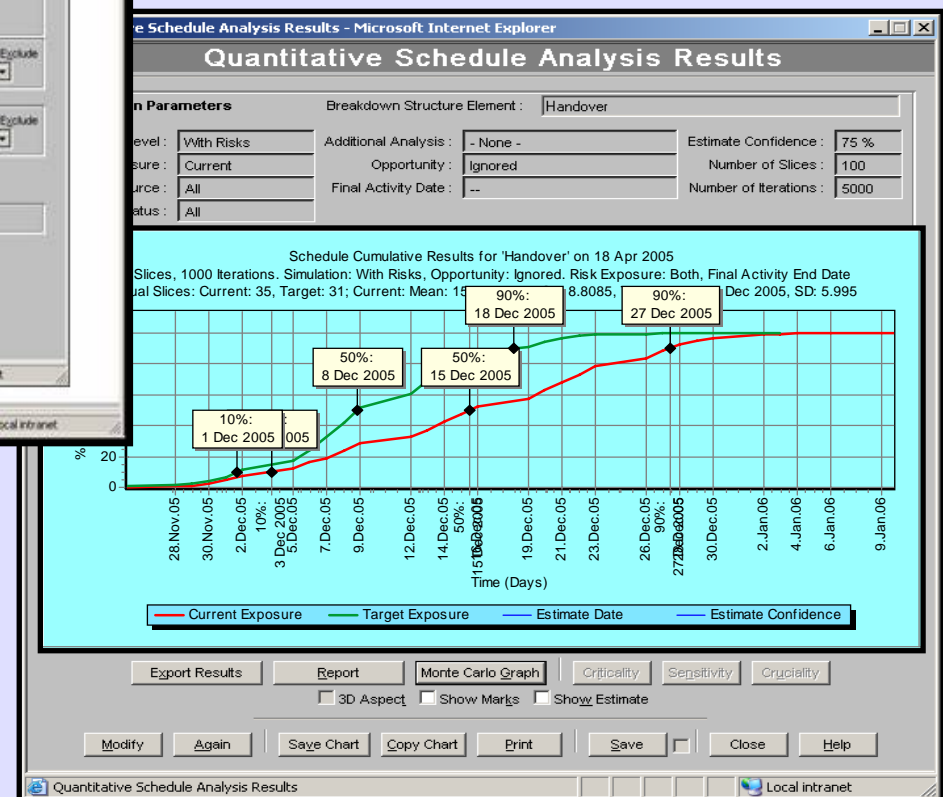
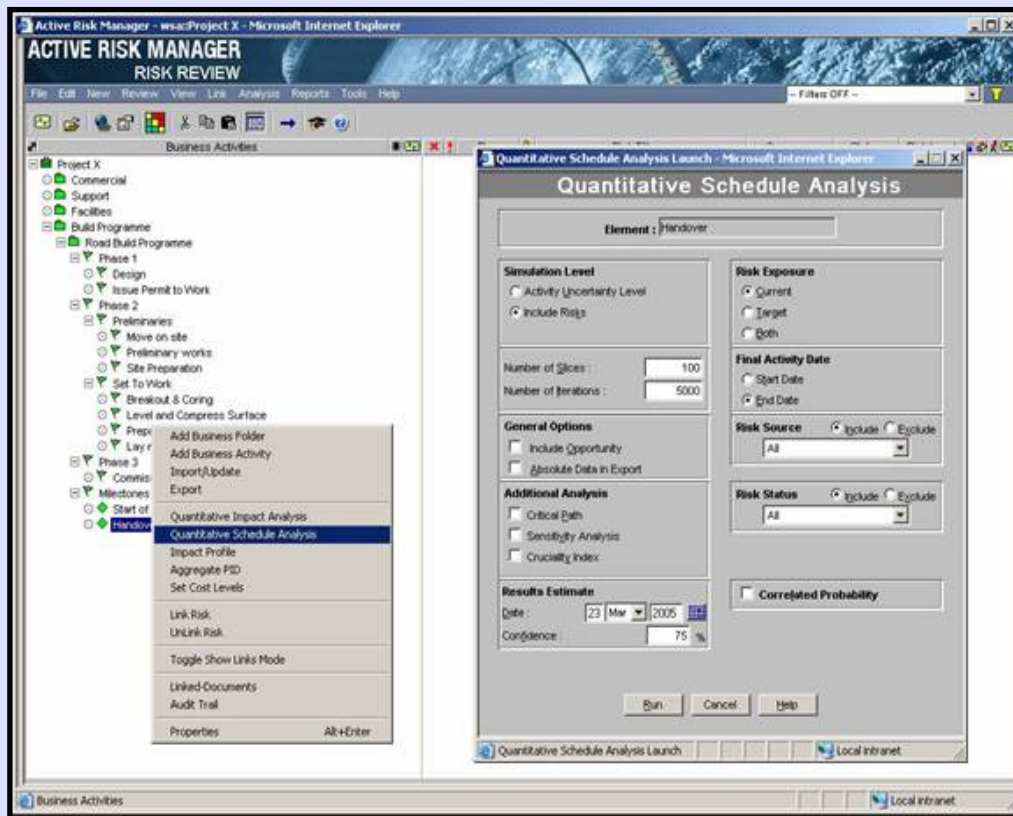
# CCRM Stage 3: Application

## Update ARM Cost Risk Assessments



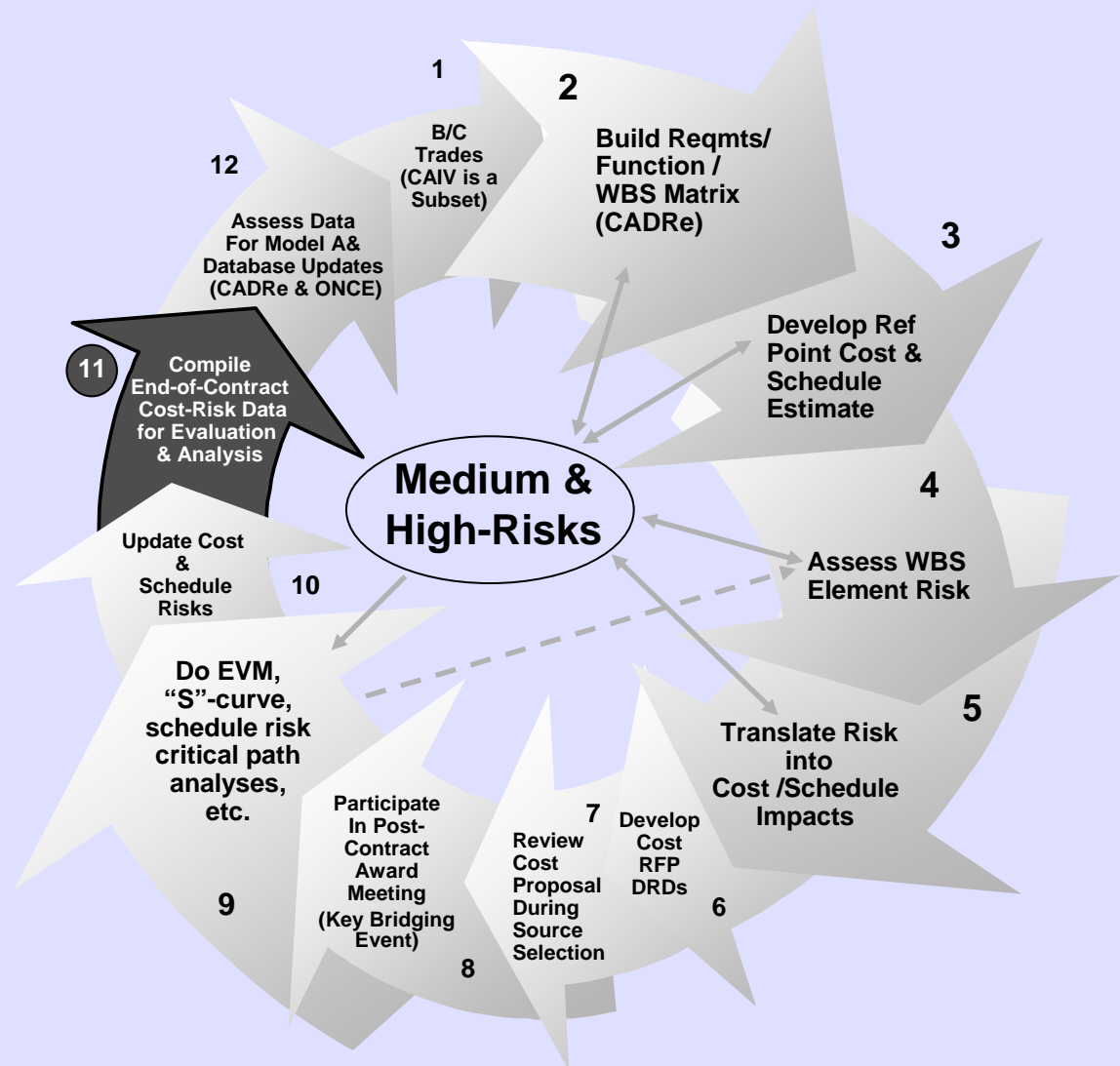
# CCRM Stage 3: Application

## Update ARM Schedule Risk Assessments



# CCRM Stage 3: Application

- Compile End – of - Contract Cost / Risk Data for Evaluation & Analysis



# CCRM Stage 3: Application

- Compile End – of - Contract Cost / Risk Data for Evaluation & Analysis

Reports Area - Active Risk Manager - Microsoft Internet Explorer

Printed On: 06 Oct 2005

Risk Data Sheet

**Risk Management Reports** | **Risk Metrics**

Standard

- Breakdown of Impacts by Ownership
- Business Analysis
- Detailed Risk Register
- Evaluation Tests
- Impact Category Summary
- Performance Against Individual Response Owner
- Qualitative Impact Record
- Qualitative Risk Register
- Qualitative Risk Summary
- Quantitative Risk Register
- Response Effectiveness Register
- Response Evaluation History
- Response Register
- Risk Data Sheet
- Risk Index
- Risk Severity By Status
- Risks Against Business Structure
- Scoring Schemes
- Summary Detail Relationships

**Report Filters and Options**

Business Area:  
Business Folder:  
Business Activity: All  
Include Children: No  
Include to Depth:  
Tree Type: None Specified  
Include Indirect:  
Summary Details:  
Impact Reassess: No  
Risk Title: All  
Risk Owner: All  
Risk Raised By: All  
Risk Source: All  
Risk Category: All  
Risk Status: All  
Risk Type: All  
Impact Group: All  
Exposure: Both  
Black Flags Filter: All  
Plan Executive: All  
Response: All  
Response Status: All  
Owner: All  
Response Type: All  
Date Filter: No date filters applied  
Custom Filter: No custom filter applied  
Ordering: Results not ordered

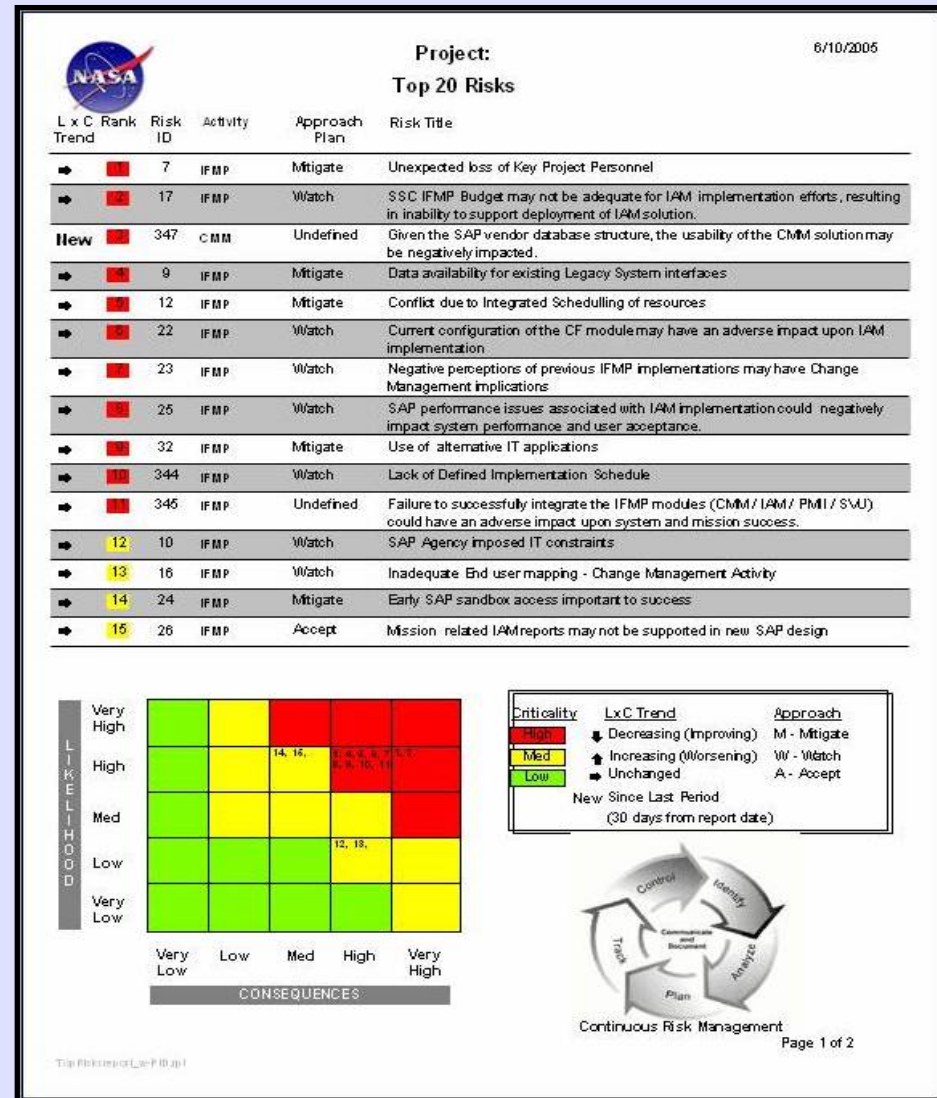
**Risk Index**

Risk ID	Risk Title	Risk Activity Name	Probability	Cost	Time	RR	Risk Level	Risk Owner	Rank
<b>Risk Status: Closed - Impacted</b>									
8	Lack of planning resources	Engineering Project Support	NIL	Significant	Marginal	0.0	NIL	Emily Jones	1
<b>Risk Status: Closed - Mitigated</b>									
6	Lack of tried and tested design strategy	System Design	NIL	Significant	NIL	0.0	NIL	Undefined	1
7	Unknown material weight coefficient	Advanced Passenger Aircraft	Very Low	Negligible	Marginal	6.0	Low	Jacob Smith	2
9	Pedestrian killed by contractor	Station Modernisation Project	NIL	Significant	NIL	0.0	NIL	Undefined	3
<b>Risk Status: Excluded</b>									
3	System Integration more complex than expected	Combat Systems	High	Marginal	Marginal	11.0	Medium	Undefined	1



# CCRM Stage 3: Application

- Easily display risk list prioritization in the form of a 'Top Ten' risk list



# ARM supports the CCRM Process



## Cost – Risk Feedback Loop

Program Managers  
Project Engineers  
Cost Estimators  
Risk Owners  
Risk Approvers  
Risk Contributors

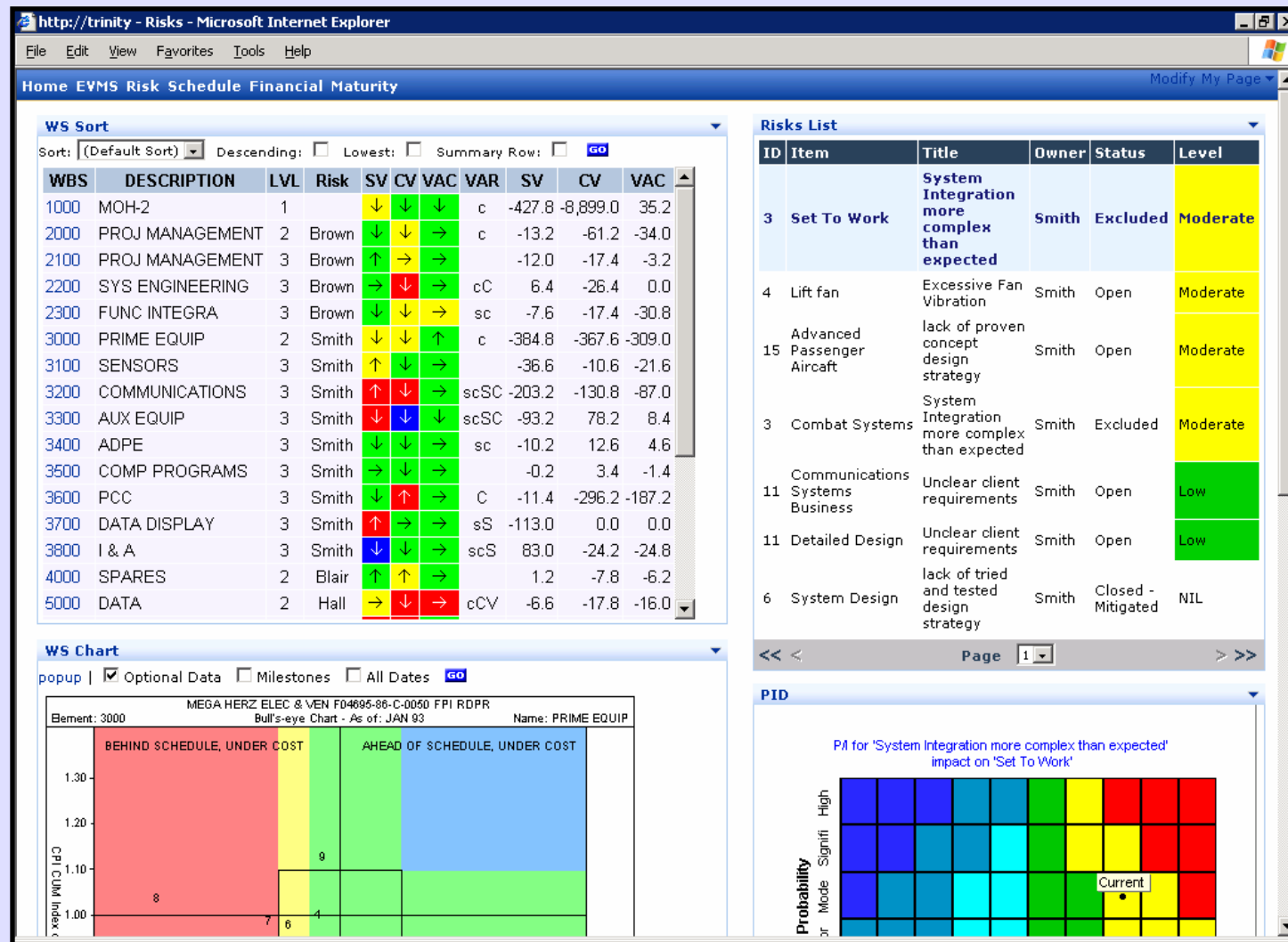
## Communicate & Manage



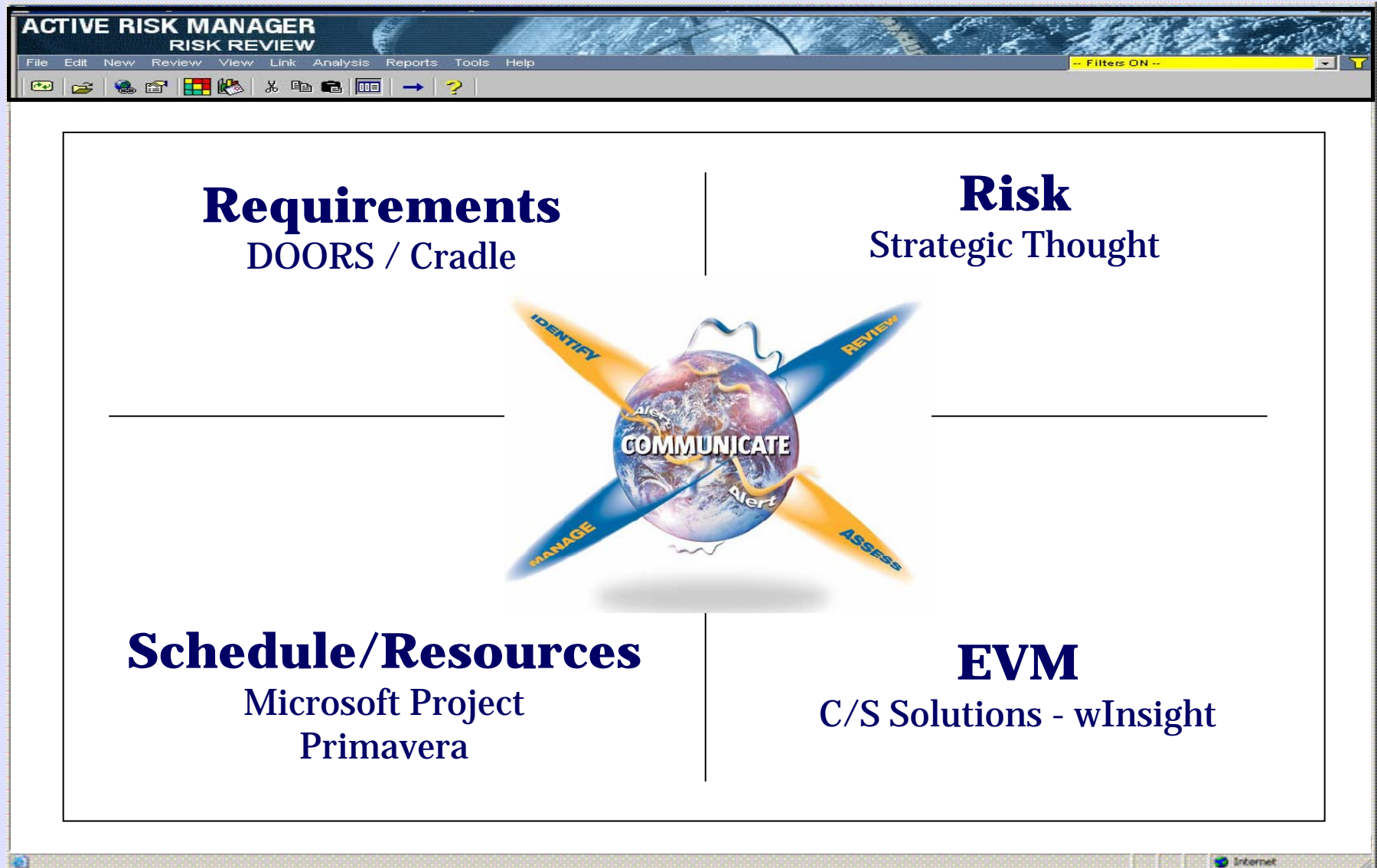


# The Future

# ARM and EVMS



# Continuous feedback on cost-risk



# **Supporting NASA's Continuous Cost Risk Management (CCRM) with Active Risk Manager**

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**Senior Risk Consultant**  
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**310.406.5684**